redpak

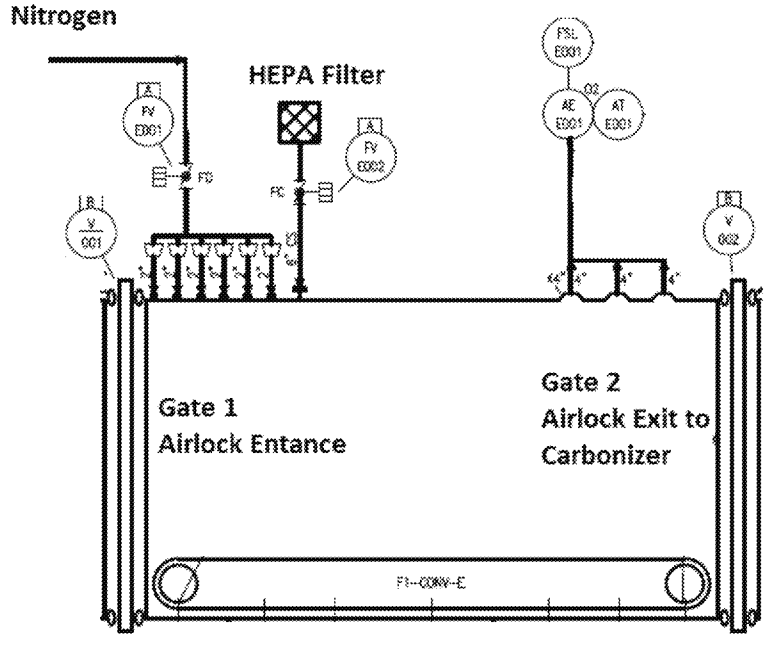
October 8, 2018

Responses to EPA's Questions Regarding the Large Carbonizer/Gasifer System and Regarding the Small-Sized Carbonizer/Gasifier System ("Small Py Unit")

Large Carbonizer/Gasifier System

Question 1: *Please explain stepwise, how the airlock system and nitrogen purge, function.*

The Carbonizer airlock system is located immediately prior to the waste shredder and feed entry into the Carbonizer. The Carbonizer airlock system consists of two (2) Airlock Gates (V001, V002), the Nitrogen Inlet Valve (FV-E001), the Air Outlet Valve (FV-E002), a HEPA Filter, and the Oxygen Analyzer (AE/AT-E001) with flow sensor (FSL E001) as shown below.



Drawing 1: Carbonizer Airlock System

The steps of operation are as follows.

Initial State Prior to Loading Waste

- The airlock chamber is filled with regular air between Gate 1 and Gate 2.
- Both gates are closed with seals inflated.
- The Nitrogen Inlet is closed.
- FV-E002 valve is open to equalize pressure across Gate 1.
- AE-E001 is reading normal O2 levels (approx. 20%).
- The shredder area and the Carbonizer, after Gate 2, are sealed and are filled with N2.

Step 1: Airlock Entrance Sequence to Load Waste

- Once boxes of waste are ready to enter the airlock, the Airlock Entrance Sequence starts.
- Gate 1's seal is deflated and Gate 1 is opened.
- Boxes are ferried onto Conveyor E (F1-CONV-E).
- Once the photoeyes see two (2) boxes on Conveyor E, Gate 1 is closed and its seals are inflated.
- Move to Step 2.

Step 2: Nitrogen Auto-Purge:

- The valve (FV-E002) for the HEPA filter remains open.
- Valve FV-E001 opens to fill the airlock chamber with N2.
- When the O2 analyzer (AE-E001) reads 3% or less O2, valve FV-E002 closes to isolate the HEPA filter.
- Move to step 3.
- If O2 does not drop to 3%, the system will pause and an alarm will sound.

Step 3: Airlock Exit

- Gate 2's seal deflates and Gate 2 is opened.
- Conveyor E moves the waste boxes to the shredder staging conveyor.
- Once the waste boxes exit the airlock, Gate 2 is closed and its seals are inflated.
- Move to Step 4.

Step 4: Airlock Equalization

- The valve FV-E001 is shut off to cease N2 flow.
- Valve FV-E002 is opened to equalize the pressure.
- The system waits in this state until the next load of waste boxes is ready to enter the airlock chamber and Step 1 begins.

Question 2: *Does the system shutdown if there is an airlock system failure?*

The system monitors Oxygen levels at points after the airlock Gate 2 before and after the shredder. As long as Gate 2 is sealed and Oxygen levels are at or below 3%, the system will run. If Oxygen levels rise above 3%:

- The system will alarm.
- The feeder screws that convey material from the shredder to the Carbonizer will automatically shut down feed. This will prevent new material from being introduced into the Carbonizer.
- The Carbonizer Isolation Gate Valve will shut to prevent oxygen introduction into the Carbonizer.
- The Carbonizer will continue to run material that had already been loaded into the Carbonizer prior to the alarm through the muffle. The Carbonizer and Char Handling System both have their own separate Nitrogen injection systems.

If the airlock malfunctions, but Gate 2 remains sealed, there is an alarm to alert the operators so that they may troubleshoot and repair and the conveyor to the shredder is automatically stopped.

Question 3: *How is the airlock system is operated, monitored (including how often and averaging time), and controlled?*

The airlock is controlled by an auto sequencer in the PLC. Each step is dependent on a set of criteria from the step before. There are timers that will set off an alarm and automatically stop the conveyor to the shredder if the system does not transfer to the next step or if a condition does not occur (for example, gate does not close, seals do not inflate, conveyor does not run). Operation of the system is monitored constantly in real time (at the sample rate of the PLC in the milliseconds). Oxygen levels are monitored continuously.

Question 4: *How does the system know there is an airlock failure (e.g., what is monitored and how often?)*

The airlock has an extensive feedback system to the PLC that monitors all aspects. Each instrument is monitored constantly, in real time, and will give an alarm if there is a malfunction. They consist of the following:

- The airlock gates have redundant feedback sensors (analog and digital position feedback) to verify that the doors are opened or closed.
- The airlock gate seals have pressure feedback sensors to verify the seals are inflated or deflated.
- The conveyor has:
    - Zero speed switches to tell whether the conveyors are moving
    - Power feedback from the drive to show that the drive is energized
    - Photoeyes that verify box position
- There are O2 analyzers to verify oxygen levels on a continuous basis in the airlock chamber and before and after the shredder after the airlock. The analyzers have a flow switch that verifies there is constant flow to the analyzer.
- There is a pressure switch on the nitrogen tank to ensure that there is sufficient nitrogen for use.
- There are cameras to allow the operators to see what is happening in the conveyor sub-system.

Question 5: *What is the source of the nitrogen? Is it 7-8% oxygen, as delivered? If not, how is the oxygen introduced and how is the oxygen concentration monitored? How frequently and what is the averaging time?*

Our nitrogen is bulk delivered as liquid nitrogen from Air Products. It is then converted to gas by onsite evaporators and delivered to the system. The nitrogen has no oxygen added (it is guaranteed by Air Products to be less than 0.001% O2).

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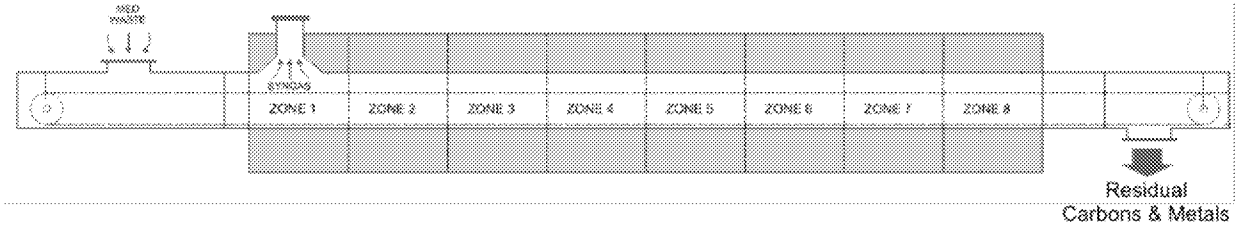
Any oxygen is introduced to the airlock chamber during the loading of waste boxes and the equalization processes (See Steps 1 & 4 in the response to Question 1). Once the airlock is ventilated and Gate 1 is open, the airlock fills with normal air. Once loaded with boxes of waste, the airlock chamber is purged again with nitrogen. While the system will tolerate 7-8% oxygen, we purge it to ~3% to provide a safety margin. The O2 analyzers provide continuous monitoring.

Question 6: *By use of the term "indirect heat" does this mean that the HMIW never comes in direct contact with the flame?*

The HMIW never comes into contact with the flames of the burners used to produce heat. The Carbonizer consists of an outer shell which houses the 32-natural gas-fired burners and an inner shell (the muffle) which houses the drag chain. The natural gas burners consist of one permanent burner in each zone. The other three burners per zone alternate firing based on temperature. The drag chain conveys the HMIW through the muffle. The muffle is air tight and nitrogen-blanketed. During every start up, the airtight integrity is verified by introducing nitrogen and verifying O2 does not exceed 3%.

The burners heat the area outside the muffle shell to achieve a maximum temperature of 1200°F for each zone inside the muffle. The system maintains a minimum of 1000°F average across all zones (Zones 1, 7, and 8 are lower than 1200°F to allow gradual heat up and cool down of the material). As seen below, the burners inhabit the gold area with 32 burners equally spaced over and below the muffle. The muffle (the white area) completely surrounds the HMIW and the syngas to keep both separated from the burner flames.



Drawing 2: The Carbonizer

Question 7: *Is the vacuum gauge connected to a central PLC that will shut the system down if the negative pressure exceeds the desired pressure range? How frequently is the negative pressure monitored and what is the averaging time?*

There are two vacuum pressure transmitters that monitor and control a negative draft on the system. The same set of fans provide negative draft through both the Thermal Oxidizer and the infeed before the Carbonizer. There is an automatic shutoff associated with these transmitters. Normal control level is -14 in of water at the Thermal Oxidizer. The Thermal Oxidizer will trip if the negative pressure drops below -10 in of water. This will in turn automatically shut off the Carbonizer. The Carbonizer has an

automatic shutdown at -3 in of water. These transmitters are monitored continuously by the PLC and will inform the operators or take automatic actions depending on the pressure level. This equates to a normal level of -7 in of water at the Carbonizer. Our permit requires at least -2.5 in of water at the Carbonizer.

Question 8: *How are the char, glass and metals removed without disturbing the negative pressure, air locks and nitrogen environment?*

The material exits the Carbonizer through the char conveyor system. Nitrogen is injected at the Carbonizer exit conveyor to cool the char and prevent any oxygen leakage into the Carbonizer. The char conveyor system has its own constant Nitrogen purge, airlock system, and oxygen monitors. The operation is as follows.

Step 1: Airlock Filled

- Conveyors 1020 and 1021 are running thereby filling containers CH1-H-1021 (1021 Hopper) and CH1-H-1022 (1022 Hopper).
- Gate 1 is open and Gate 2 is shut.
- Nitrogen is continuously fed into Hopper 1022 and the nitrogen fills the char conveyor system from the Carbonizer exit to Gate 2.
- Analyzers on each of the hoppers are continuously monitoring Oxygen levels.
- There is also an explosive gas analyzer on Hopper 1021 to detect any syngas migration through the char system.

Step 2: Airlock Emptied

- Once Hopper 1022 fills, Gate 1 is shut and conveyor 1021 is stopped.
- Gate 2 opens and Conveyor 1022 is started to transfer material to the char/metal separator.
- Nitrogen is still added to the Hopper 1022 so that Hopper 1022 and Conveyor 1022 remains purged of oxygen.
- Once Hopper 1022 is empty, the system returns to step 1.

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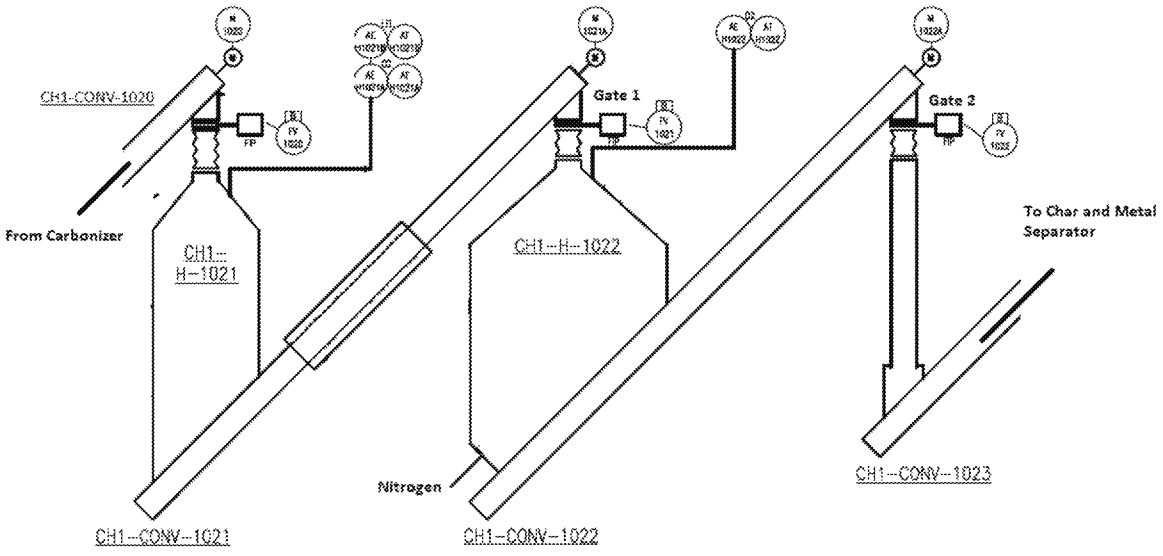

Drawing 3: The Char Airlock

Question 9: *Please provide a temperature profile of the chamber over the time of a cycle, which includes cold start, firing with natural gas, introduction of HMWI, production of syngas, removal of char, glass and metal from the unit. Please clearly depict the steps on the graph.*

The graph below shows a typical startup of the Carbonizer (an average of Zones 1-8). The area outside the Carbonizer chamber (muffle) is heated by natural gas-fired burners. After the initial firing of the burners, the temperature inside the Carbonizer muffle quickly climbs to 400°F and then the muffle is heated up at 100°F/ Hr. When the temperature inside the muffle reaches an average of 1000°F, HMIW is introduced for processing. The entire process is continuous, so the syngas production and residual solids removal are all occurring simultaneously. These have little effect on actual temperature within the muffle since the burners maintain temperature at a setpoint of 900-1200°F, depending on the zone. Char exits the Carbonizer between 100-250°F depending on the material. The char is cooled quickly as it travels through the char conveyors due to the Nitrogen injected at the Carbonizer exit conveyors.

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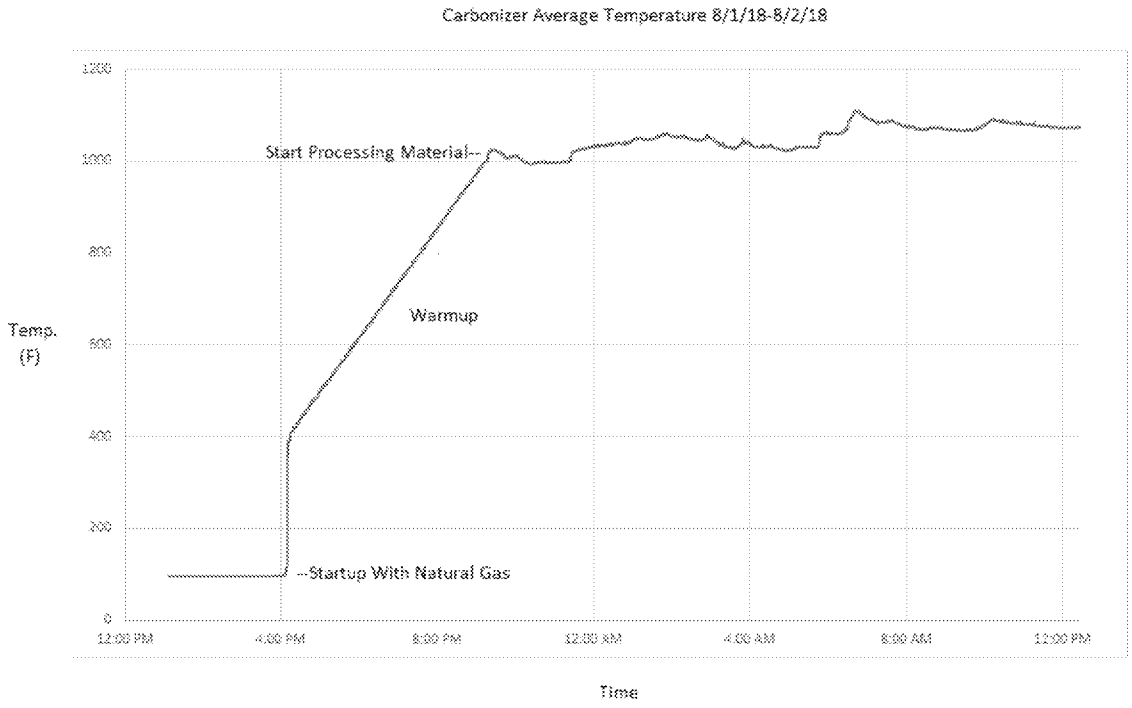

Question 10: *Please provide the natural gas-firing rate of the burners over the time of cycle, which includes cold start, firing with natural gas, introduction of HMWI, production of syngas, and removal of char, glass and metal from the unit. Please clearly depict the steps as they coincide with the firing rate.*

See above for the temperature profile.

The plant does not have an independent gas flow meter for the burners that heat the area around the Carbonizer muffle. Because we only have a total plant usage meter the firing rates for the burners are not monitored. Only the temperatures of the zones within the Carbonizer muffle are monitored.

As noted before, the introduction of HMWI, the production and subsequent handling of the syngas, and the removal of the Residuals are continuous and independent from the firing cycle, whose only purpose is to set and then maintain the indirect heating levels of the zones of the muffle.

Question 11: *Are there any other air pollution control devices before or after the thermal oxidizer? If yes, please describe their function and the parameters which are monitored (including frequency and averaging times).*

The thermal oxidizer exhaust is controlled by a dry scrubber with hydrated calcium lime injection (DSI). The DSI exhausts to a three-module baghouse. These controls are operated to maintain

HCl and particulate less than our current Subpart Ec permit limits of 5.1 ppmvd for HCl and 16 mg per dscm for particulate. HCl is measured during stack testing. DSI sorbent flow rates are monitored a minimum of once per hour. The baghouse is equipped with a compliant leak detector system that monitors particulate matter. The inlet temperature of the baghouse is monitored continuously and recorded in one-minute averages. Opacity is monitored as a six-minute block average. An emergency enclosed flare is available in the event of a catastrophic failure of the DSI.

Question 12: *Please provide an analysis (chemical characterization) of the resultant syngas.*

Please see attached summary of analytical results for syngas samples collected in 2015 at the inlet tank of the TO for the mid-sized Carbonizer/Gasifier system then located in Fortville, Indiana. This profile continues to be typical.

Question 13: *Please include the results of any performance tests on the unit, and identify the sampling points (e.g. after the py unit/before the TO/after the TO).)*

Compliance Subpart Ec stack testing required by our permits ended as of Oct. 2, 2018. All real-time monitorable parameter testing (CO, NOx, HCL, opacity, etc.) were all determined to be less that permit limits; i.e., the testing was all successful. We await the remainder of the test results.

Question 14: *Please describe any additional monitoring (e.g. fugitives).*

The system has a CEMS for CO monitoring located at the exhaust stack after the baghouse. This takes a heated stack sample and runs it through a CO analyzer. It is monitored continuously to demonstrate compliance with the CO limit of 11 ppmvd based on 24-hour block average.

The Carbonizer has the following monitored:

- Waste loading rate to the Carbonizer when the boxes are entered into the system
- Operating temperatures for each zone in the muffle are monitored continuously and recorded in one-minute averages
- Carbonizer drag chain drive speed is monitored continuously and recorded in one-minute averages.

The thermal oxidizer operating temperature is continuously monitored in 1-minute averages.

The exhaust stack temperature is continuously monitored in 1-minute averages

"Small Py Unit"

Question 1: *Please describe how you ensure the small py unit remains oxygen free?*

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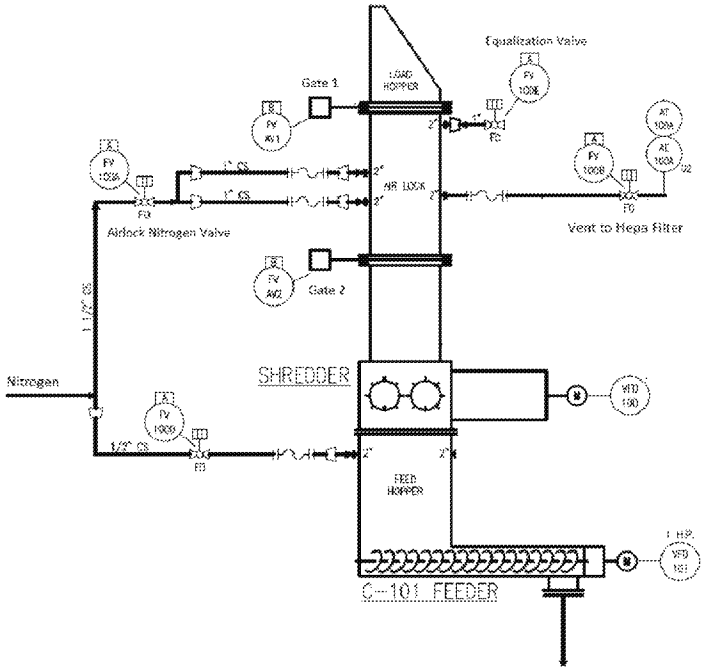


Drawing 4: Small Carbonizer Unit (also "Py unit") Infeed System

The steps of operation are as follows.

Initial State Prior to Loading Waste

- The airlock chamber is filled with regular air between Gate 1 (FV-AV1) and Gate 2 (FV-AV2).
- Both gates are closed with seals inflated.
- The Nitrogen Inlet to the airlock (FV-100A) is closed.
- Nitrogen is applied to the Feeder Screw through FV-100D
- FV-100E valve is open to equalize pressure across Gate 1.
- AE-100A is reading normal O2 levels (approx. 20%).
- The Vent Valve to the HEPA filter (FV-100B) is closed

Step 1: Airlock Entrance Sequence to Load Waste

- Once boxes of waste are ready to enter the airlock, the operator opens Gate 1.
- Gate 1's seal is deflated and Gate 1 is opened.
- The operator drops the box into the chute
- Once the operator has dropped the boxes, he activates the sequence and Gate 1 is closed and its seals are inflated.
- Move to Step 2.

Step 2: Nitrogen Auto-Purge:

- The equalization Valve (FV100E) closes
- The valve (FV-100B) for the HEPA filter opens.

- Valve FV-100A opens to fill the airlock chamber with N2.
- When the O2 analyzer (AE-100A) reads 3% or less O2, valve FV-100B closes to isolate the HEPA filter.
- Move to step 3.
- If O2 does not drop to 3%, the system will pause and an alarm will sound.

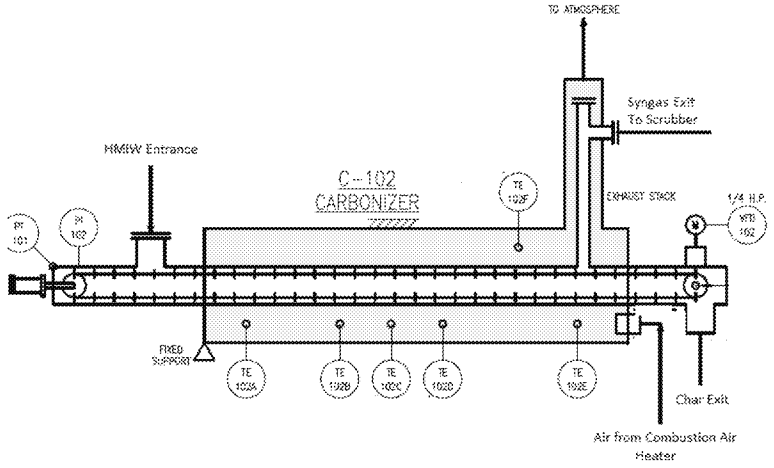
Step 3: Airlock Exit

- Gate 2's seal deflates and Gate 2 is opened.
- The box drops to the shredder
- Once the waste boxes exit the airlock, Gate 2 is closed and its seals are inflated.
- Move to Step 4.

Step 4: Airlock Equalization

- The valve FV-100A is shut off to cease N2 flow.
- Valve FV-100E is opened to equalize the pressure.
- The system waits in this state until the operator is ready to load the next box.

Question 2: *Please answer Q6, above, for the small py unit.*



Drawing 5: Small Py Unit Carbonizer

The HMIW never comes into contact with the flames of the burners used to produce heat. The Carbonizer, regardless of size, consists of an outer shell which houses hot combustion air and an inner shell (the muffle) which houses the drag chain. The drag chain conveys the HMIW through the muffle. The muffle is air tight and nitrogen-blanketed.

The burner is separate from the Carbonizer and is connected to the outer shell through a heat tube and a combustion blower. The combustion air heats the area outside the muffle shell (the yellow area in drawing 5) to 1200°F at the combustion air inlet and 1000°F at the exit to atmosphere. The muffle (the white area) completely surrounds the HMIW and the syngas to keep both separated from the burner flames. The syngas leaves through a separate system to a venturi scrubber which vents to an enclosed flare system.

Question 3: *Please provide a temperature profile of the py chamber and the natural gas-firing rate of the burner, as described in items 9 & 10, above.*

The small unit has a small pyrolysis chamber with only one heat zone. The chamber temperature, hot air entrance and exit temperatures, and the char exit temperature are measured continuously.

Question 4: *Please provide an analysis (chemical characterization) of the resultant syngas.*

No additional testing is planned as it is not required by the permit.

Question 5: *Please include the results of any performance tests on the unit, and identify the sampling points (e.g. after the py unit/before the venturi scrubber/before the flare/after the flare).*

Performance testing is not planned at this time as it is not required by the permit.

Question 6: *Please describe any additional monitoring (e.g. fugitives).*

The system has O2 monitors in the airlock and after the shredder that are displayed continuously and recorded hourly in the logs. An alarm will sound if O2 is greater than 3% to alert the operator.

The system is kept under a vacuum through a liquid ring vacuum pump. It maintains -4 in of water. The vacuum is monitored continuously and recorded hourly.

The Carbonizer temperature will alarm on high temperature of 1350°F. This temperature is monitored continuously and recorded hourly.

Scrubber solution pH is monitored on a daily basis.